

A PROCESS FOR THE MANUFACTURING OF  
AN IMPROVED CORE FOR DECORATIVE LAMINATES AND A  
DECORATIVE LAMINATE OBTAINED BY THE PROCESS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a non-provisional application claiming the benefit of provisional application serial number 60/217,016, filed July 11, 2000, the entire disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a process for manufacturing a board used as a core in decorative laminates and a decorative laminate obtained by the process.

2. Description of the Related Art

Products clad with thermosetting laminates are quite common nowadays. They are most often used where the demand for abrasion resistance is great but also where resistance towards different chemical substances and moisture is required. Floors, floor skirtings, work tops, table tops, doors and wall panels can serve as an example of such products. The thermosetting laminate is most often made from a number of base sheets and a decorative sheet placed closest to the surface. The decorative sheet may be provided with the desired decor or pattern. Thicker laminates are often provided with a core of particle board or fibre board where both sides are covered with sheets of thermosetting laminate. The outermost sheet is, on at least one side, most often a decorative sheet. One problem with such thicker laminates is that the core is much softer than the surface layer which is made from paper impregnated with thermosetting resin. This will cause a considerably reduced

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resistance towards thrusts and blows compared to a laminate with a corresponding thickness made of paper impregnated with thermosetting resin only.

Another problem with thicker laminates with a core of particle board or fibre board is that these normally will absorb a large amount of moisture, which will cause them to expand and soften whereby the laminate will warp. The surface layer might even, partly or completely come off in extreme cases since the core will expand more than the surface layer. This type of laminate can therefore not be used in humid areas, such as bath rooms or kitchens, without problem.

The problems can be partly solved by making the core of paper impregnated with thermosetting resin as well. Such a laminate is most often called compact laminate. These compact laminates are, however, very expensive and laborious to obtain as several tens of layers of paper have to be impregnated, dried and put in layers. The direction of the fibre in the paper does furthermore cause a moisture and temperature difference relating expansion. This expansion is two to three times as high in the direction crossing the fibre than along the fibre. The longitudinal direction of the fibre is coinciding with the longitudinal direction of the paper. One will furthermore be restricted to use cellulose as a base in the manufacturing though other materials could prove suitable.

It is known to manufacture boards of recycled rigid polyurethane foam particles bonded by using MDI as a glue. These polyurethane particle boards are, however, not suited as cores in laminates such as the ones described above since the particles normally will expand when heated. This expansion will cause blistering close to the surface which will cause the surface to de-laminate locally from the core. Another problem with such polyurethane based boards is that they absorb moisture up to a level of about 5% calculated on a 100% relative humidity environment. Humidity absorption will cause expansion which leads to de-lamination and possibly warping of such boards.

## SUMMARY OF THE INVENTION

The above problems have through the present invention been solved whereby a flexible process for the manufacturing of a mainly isometric and preconditioned core to a decorative laminate has been achieved. Accordingly the invention relates to a process for the manufacturing of a core forming a carrying structure for decorative laminates. The core comprises particles of cured, and possibly foamed, rigid, polyurethane, polyisocyanurate and/or phenolic resin, which particles are bonded to each other in a pressing procedure with a bonding agent comprising an adhesive such as a polymerizing monomer. The invention is characterized in that;

i) The particles are achieved by grinding cured, and possibly foamed, rigid, polyurethane, polyisocyanurate and/or phenolic resin so that it passes through a 2 mm screen, preferably a 1 mm screen;

ii) The particles are allowed to absorb a selected amount of water, the amount of water being in the range 1 - 15 % by weight. The water is either added at any stage before the adding of bonding agent, and/or being used as a solvent in the bonding agent;

iii) 85 parts per weight of the particle mixture is mixed with 2 - 15 parts per weight of a bonding agent, the bonding agent selected from the group consisting of,

a) a mixture of polyols, such as polyester or polyether, crude methylene diphenyl diisocyanate and possibly a small amount of blowing agent in a ratio forming a polymeric resin with a density in the range 600 - 1400 kg/m<sup>3</sup>;

b) the bonding agent may also or alternatively consist of a formaldehyde based resin such as phenol-formaldehyde resin, urea- formaldehyde resin, melamine-urea-formaldehyde resin, melamine-urea-phenol-formaldehyde resin or phenol-resorcinol-formaldehyde resin;

c) the bonding agent may also or alternatively consist of polyvinyl acetate resin;

iv) the mixture is applied in a continuous or static press, possibly with at least one intermediate carrier web, the press allowing a mainly uniform and specified material thickness to form, whereby a slightly porous and preconditioned core with a selected water content in the range 0.8 - 12 % is achieved.

The pressure cycle characteristics are typically in the range; pressure 20 - 70 MPa, temperature 110°C - 170°C and a duration of 45 seconds - 4 minutes. It is possible to achieve boards with different mechanical properties by altering the pressure cycle characteristics as well as the raw material composition within the scope of the invention. However typical process parameters would suitably be: pressure 50 MPa, temperature 150°C and a duration of 3 minutes.

A flame retardant comprising halogens such as tri-chlorophosphate is preferably included in the mixture forming the core.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Suitable isocyanate-reactive compounds to be used in the process of the present invention include any of those known in the art for the preparation of rigid polyurethane or urethane-modified polyisocyanurate foams. Of particular importance for the preparation of rigid foams are polyols and polyol mixtures having average hydroxyl numbers of from 100 to 1000, especially from 100 to 700 mg KOH/g, and hydroxyl functionalities of from 2 to 8, especially from 3 to 8. Suitable polyols have been fully described in the prior art and include reaction products of alkylene oxides, for example

ethylene oxide and/or propylene oxide, with initiators containing from 2 to 8 active hydrogen atoms per molecule. Suitable initiators include: polyols, for example glycerol, sorbitol, sucrose, triethanolamine, 2-hydroxyalkyl-1,3-propanediols, 2-hydroxyalkyl-2-alkyl-1,3-propane diols, 2,2-hydroxyalkyl-1,3-propane diols, 2-hydroxyalkoxy-1,3-propanediols, 2-hydroxyalkoxy-2-alkyl-1,3-propanediols and 2,2-hydroxyalkoxy-1,3-propanediols, such as trimethylolethane, trimethylolpropane and pentaerythritol, as well as dimers, trimers and polymers thereof; polyamines, for example, ethylene diamine, tolylene diamine (TDA), diaminodiphenylmethane (DADPM) and polymethylene polyphenylene polyamines; and aminoalcohols, for example, ethanolamine and diethanolamine, and mixtures of such initiators. Other suitable polymeric polyols include polyesters obtained by the condensation of appropriate proportions of glycols and higher functionality polyols with dicarboxylic or polycarboxylic acids. Still further suitable polymeric polyols include hydroxyl terminated polythioethers, polyamides, polyesteramides, polycarbonates, polyacetals, polyolefins, polysiloxanes and starbranched, hyperbranched and dendritic polyester and polyether alcohols.

Suitable organic polyisocyanates for use in the process of the present invention include any of those known in the art for the preparation of rigid polyurethane or urethane-modified polyisocyanurate foams and, in particular, the aromatic polyisocyanates such as diphenylmethane diisocyanate in the form of its 2,4', 2,2' and 4,4' isomers and mixtures thereof, the mixtures of diphenylmethane diisocyanates (MDI) and oligomers thereof known in the art as "crude" or polymeric MDI (polymethylene polyphenylene polyisocyanates) having an isocyanate functionality of greater than 2, toluene diisocyanate in the form of its 2,4 and 2,6 isomers and mixtures thereof, 1,5 naphthalene diisocyanate and 1,4 diisocyanatobenzene. Other organic polyisocyanates which

may be mentioned include the aliphatic diisocyanates such as isophorone diisocyanate, 1,6 diisocyanatohexane and 4,4' diisocyanato-dicyclohexylmethane.

The quantities of the polyisocyanate compositions and the polyfunctional isocyanate-reactive compositions to be reacted will depend upon the nature of the rigid polyurethane or urethane-modified polyisocyanurate foam to be produced and will be readily determined by those skilled in the art.

The water captured in the raw materials (especially the polyols) can be used as blowing agent, when properly monitored. Otherwise, the polyol stream needs to be desiccated before micro-dosing a blowing agent commonly used. Blowing agents proposed in the prior art include hydrochloro fluorocarbons, hydrofluorocarbons and especially hydrocarbons namely alkanes and cycloalkanes such as isobutane, n-pentane, isopentane, cyclopentane and mixtures thereof as well as water or any other carbon dioxide-evolving compounds.

In addition to the polyisocyanate and polyfunctional isocyanate-reactive compositions and the blowing agent mixture, the foam-forming reaction mixture will commonly contain one or more other auxiliaries or additives conventional to formulations for the production of rigid polyurethane and urethane-modified polyisocyanurate foams. Such optional additives include crosslinking agents, for example low molecular weight polyols such as triethanolamine, foam-stabilising agents or surfactants, for example siloxane-oxyalkylene copolymers, urethane catalysts, for example, tin compounds such as stannous octoate or dibutyltin dilaurate or tertiary amines, such as dimethylcyclohexylamine or triethylene diamine, isocyanurate catalysts, fire retardants, for example, halogenated alkyl phosphates, such as tris chloropropyl phosphate, color pigmentation and fillers, such as carbon black.

It is also possible to adapt the mechanical properties of the material by adding other materials such as particles or fibre. These type of additives can be used for a number of reasons. Additives may be used to alter adjust or improve acoustic properties, density, thermal coefficient of expansion, thermal conductivity, flexibility, rigidity and brittleness. A proper filler may also reduce the manufacturing costs. Typical particle fillers are minerals such as mica and lime, while common fibre fillers are glass, carbon, steel, aramide and cellulose fibres.

According to one embodiment of the invention, the core is provided with a decorative upper surface after the manufacturing of the core.

According to another embodiment, the core is provided with a decorative upper surface during the manufacturing of the core.

According to one embodiment of the invention, the first surface webs, constituting a decorative upper surface, is manufactured by laminating at least one uppermost so-called overlay web of melamine-formaldehyde resin impregnated  $\alpha$ -cellulose paper with at least one decorative web of decorated melamine-formaldehyde resin impregnated  $\alpha$ -cellulose paper and possibly a group of support webs under heat and pressure so that the resin cures at least partially and the webs are bonded to one another, preferably while the polyurethane core is formed. The support layer webs are suitably forming a part of the decorative upper surface. The group of support layer webs comprises one or more monochromatic webs of  $\alpha$ -cellulose impregnated with melamine-formaldehyde resin and/or one or more Kraft-paper webs impregnated with phenol-formaldehyde resin, urea-formaldehyde resin, melamine-formaldehyde resin or combinations thereof. In order to improve the abrasion resistance, the overlay webs and optionally the decorative paper webs preferably includes 2 - 100 g/m<sup>2</sup> per layer of hard particles of  $\alpha$ -aluminum oxide, silicon carbide or

silicon oxide having an average particle size in the range 50nm - 150  $\mu\text{m}$ . The upper surface of the uppermost overlay web suitably contains 2 - 100 g/m<sup>2</sup> of hard particles of  $\alpha$ -aluminum oxide, silicon carbide or silicon oxide having an average particle size in the range 50nm - 30  $\mu\text{m}$ . This will improve the scratch resistance.

In cases where an upper surface with very high demands is needed, the decorative upper surface is suitably laminated and at least partially cured prior to the part of the process where the core is achieved and bonded to the decorative upper surface.

In processes where the upper surfaces are bonded to each other at the same time as the core is formed, the pressure in the belt press is suitably increased towards the end of pressing cycle.

According to another embodiment of the invention the first surface web is constituted by a printed foil. The printed foil is suitably made of  $\alpha$ -cellulose impregnated with a polymeric lacquer or resin such as melamine-formaldehyde, urea-formaldehyde acrylic, maleamid, polyurethane or the like. The printed foil may alternatively be made of a polymer such as polyvinyl-chloride, polyester, polypropylene, polyethylene, polyurethane, acrylic or the like. The upper surface is suitably coated with one or more wear-resistant layers of acrylic or maleamid lacquer on top of the printed foil after having passed through the continuous belt press. The lacquer is preferably of an UV- or electron-beam curing type and is suitably applied in two or more layers with intermediate stages of partial or complete curing. In order to improve the abrasion resistance, the lacquer preferably includes 2 - 100 g/m<sup>2</sup> per layer of hard particles of  $\alpha$ -aluminum oxide, silicon carbide or silicon oxide having an average particle size in the range 50nm - 150  $\mu\text{m}$ . The scratch resistance may be improved by applying 2 - 100 g/m<sup>2</sup> of hard particles of  $\alpha$ -aluminum oxide, silicon carbide or silicon oxide having



an average particle size in the range 50nm - 30  $\mu$ m on the upper surface of the uppermost layer of lacquer.

According to yet another embodiment of the invention, the first surface web is constituted by a translucent or semi-translucent layer. The particles of the core are suitably deviating in color from the polymeric resin, which resin suitably also comprises pigmentation. The semi-translucent layer is preferably constituted of a foil or a web which is provided with a printed decor which decor preferably is semi-translucent or opaque, covering only parts of the surface of the foil or web. The semi-translucent foil or web is preferably constituted of  $\alpha$ -cellulose impregnated with a polymeric resin or lacquer such as melamine-formaldehyde, urea-formaldehyde, polyurethane, acrylic or maleamide. The semi-translucent foil or web is alternatively constituted of a polymer, such as polyvinyl -chloride acrylic, polyester, polypropylene, polyethylene, polyurethane or the like. A wear layer, or a number of wear layers are preferably applied on top of the foil or web. The wear layers are suitably constituted of  $\alpha$ -cellulose impregnated with a polymeric resin or lacquer such as melamine- formaldehyde, urea- formaldehyde, polyurethane, acrylic or maleamid. The wear layers are alternatively constituted of a lacquer such as acrylic or maleamide, possibly of a UV- or electron-beam curing type. Such a lacquer is preferably applied in two or more layers with intermediate stages of partial or complete curing.

In order to improve abrasion resistance, the wear layer suitably includes 2 - 100 g/m<sup>2</sup> per layer of hard particles of  $\alpha$ -aluminum oxide, silicon carbide or silicon oxide having an average particle size in the range 50nm - 150  $\mu$ m. The scratch resistance can suitably be improved by applying 2 - 100 g/m<sup>2</sup> of hard particles of aluminum oxide, silicon carbide or silicon oxide having

an average particle size in the range 50nm - 30  $\mu$ m on the upper surface of the uppermost layer of lacquer.

According to yet another embodiment of the invention, a decor is applied on the upper side of the first surface web or the upper side of the core. The decor is, according to the embodiment, printed directly on the surface or applied on the surface via transfer printing, possibly after having sanded and/or coated the surface of the core. A wear layer or a number of wear layers are suitably applied on top of the decor. The wear layers are here suitably constituted of  $\alpha$ -cellulose impregnated with a polymeric resin or lacquer such as melamine-formaldehyde, urea-formaldehyde, polyurethane, acrylic or maleamid. The wear layers are alternatively constituted of a lacquer such as acrylic or maleamide, possibly of a UV- or electron-beam curing type. Such a lacquer is suitably applied in two or more layers with intermediate stages of partial or complete curing. In order to improve the abrasion resistance the wear layer preferably includes 2 - 100 g/m<sup>2</sup> per layer of hard particles of  $\alpha$ -aluminum oxide, silicon carbide or silicon oxide having an average particle size in the range 50nm - 150  $\mu$ m. The scratch resistance is preferably improved by applying 2 - 100 g/m<sup>2</sup> of hard particles of  $\alpha$ -aluminum oxide, silicon carbide or silicon oxide having an average particle size in the range 50nm - 30  $\mu$ m on the upper surface of the uppermost layer of lacquer.

The invention also relates to a decorative laminate achieved through the process, the decorative laminate comprising a core, at least an upper abrasion resistant decorative layer, and edges provided with means for joining. The core comprises particles of cured, and possibly foamed, rigid, polyurethane, polyisocyanurate and/or phenolic resin, which particles are bonded to each other in a pressing procedure with a bonding agent comprising an adhesive such as a polymerizing monomer. The invention is characterized in that:

i) the particles of the core are constituted of ground, possibly foamed, rigid, polyurethane, polyisocyanurate and/or phenolic resin smaller than 2 mm, preferably 1 mm, most preferably with a size partition of below 5% of particles larger than 1 mm, 25% - 75% of particles larger than 0.5 mm and 25 - 75 % of particles smaller than 0.5 mm. The parties can be sized by screening.

The core comprises 85 - 97 parts per weight of particles and 3 - 15 parts per weight of a bonding agent, the bonding agent selected from the group consisting of:

a) a mixture of polyols, such as polyester or polyether, crude methylene diphenyl diisocyanate and possibly a small amount of blowing agent in a ratio forming a polymeric resin with a density in the range 600 - 1400 kg/m<sup>3</sup>;

b) a phenolic resin such as phenol-formaldehyde resin, urea-formaldehyde resin or mixtures thereof; and

c) a polyvinyl acetate resin;

iii) The core is also preconditioned to a moisture content in the range 0.8 - 12 %.